ASSIGNMENT - 4

Q1) Design an audio power amplifier with preamp having variable gain.

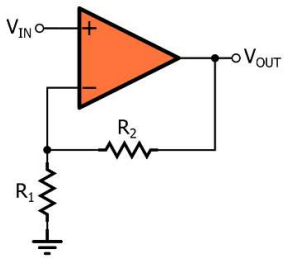
Solution:

The function of audio power amplifier is to amplify the input signal from the audio source, and then drive it to the speaker. It mainly consists of three units: preamplifier unit, tonality control unit and power amplifier unit.

(As we weren't given transistors, we were asked only to build a preamp with variable gain.)

A pre-amplifier is required to amplify a signal, when the source level is too low and has to be pre-amplified in order to be able for further processing, control or any other use.

A pre-amp uses a non-inverting amplifier to amplify the input signal. Here as the input signal is an audio signal, we use a 2-terminal electret microphone to take input audio signals.

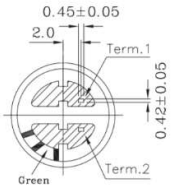


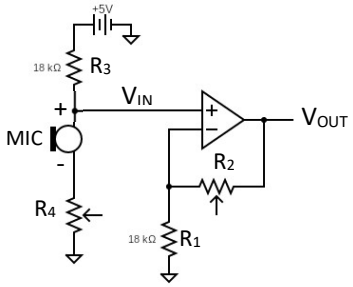
On the left is the non-inverting amplifier whose voltage gain can be calculated using the equation

$$V_{OUT} = (1 + \frac{R_2}{R_1}) \cdot V_{IN}$$

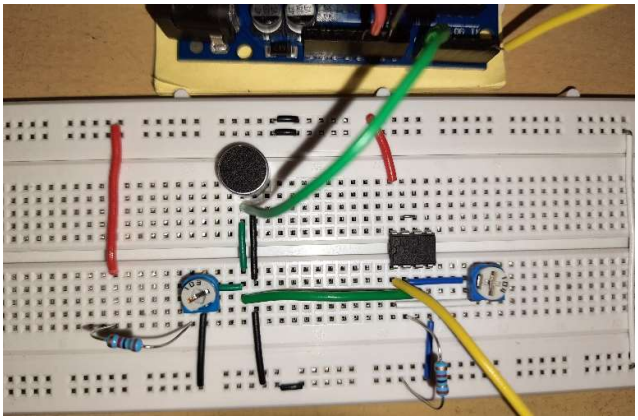
As we need variable gain, we replace resistor R_2 with a variable resistor-trimpot (104) to get a PREAMPLIFIER WITH VARIABLE GAIN.

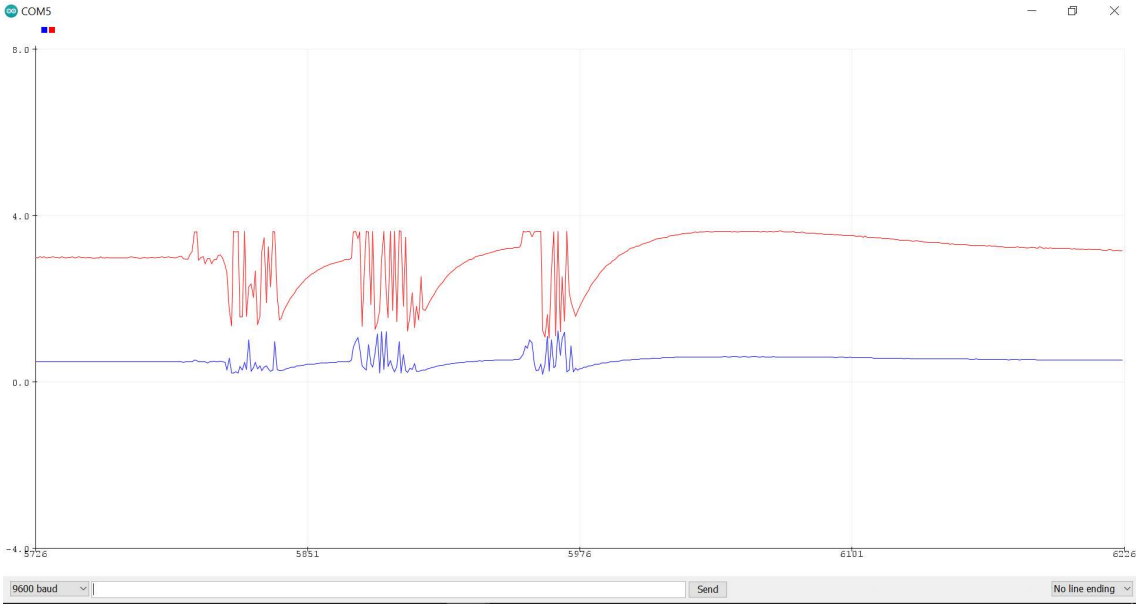
On the right is the diagram of an electret microphone used to take input audio signals. The electret microphone is connected to non-inverting amplifier in the following way

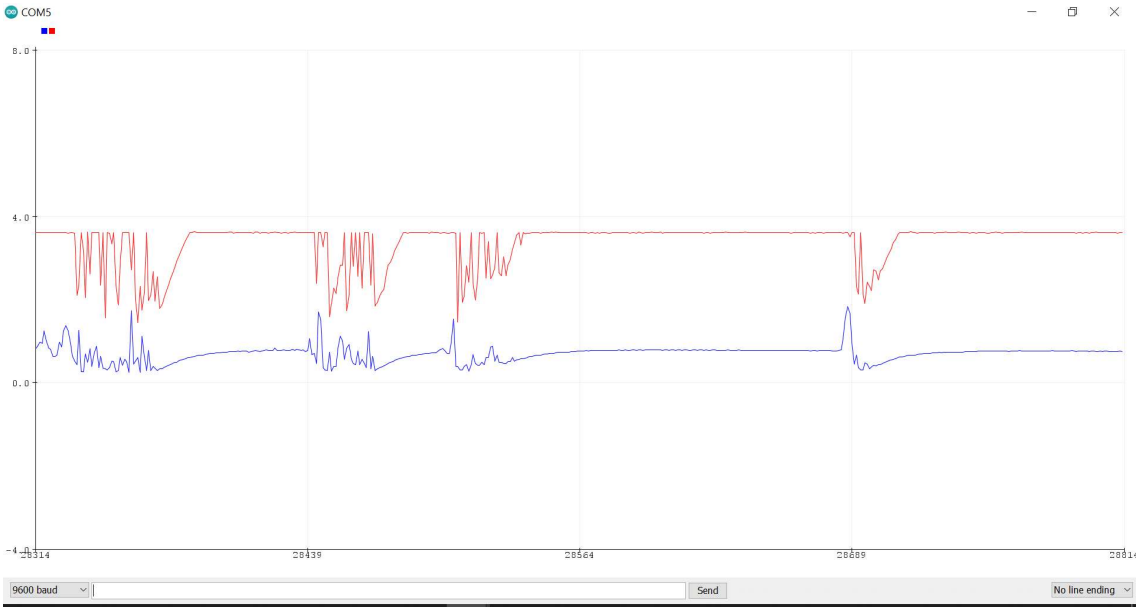




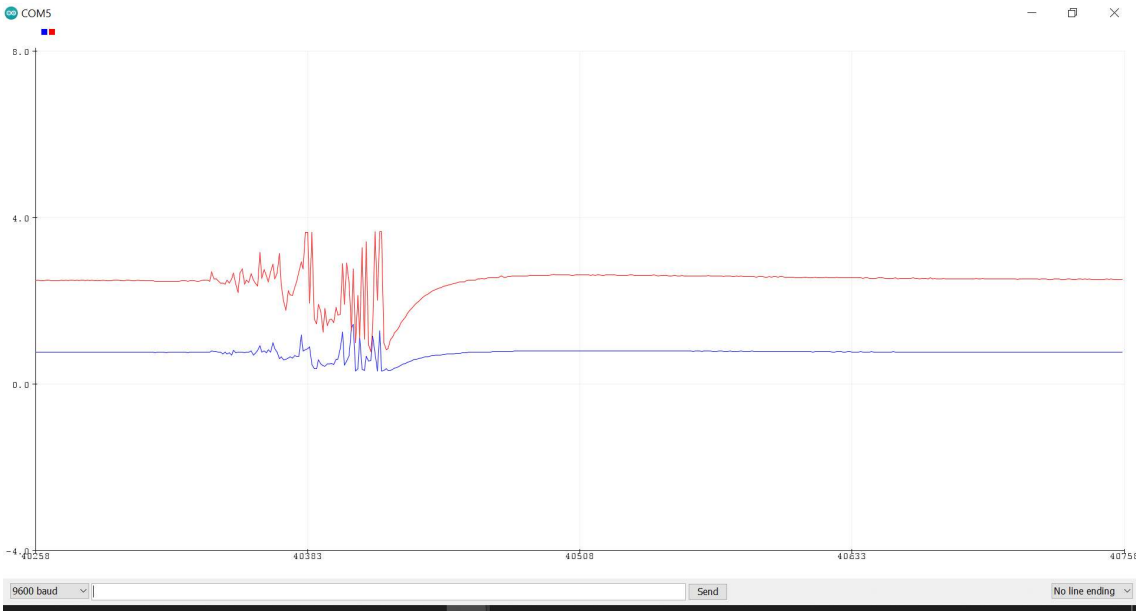
Below is the circuit on breadboard followed by Arduino output using serial plotter.







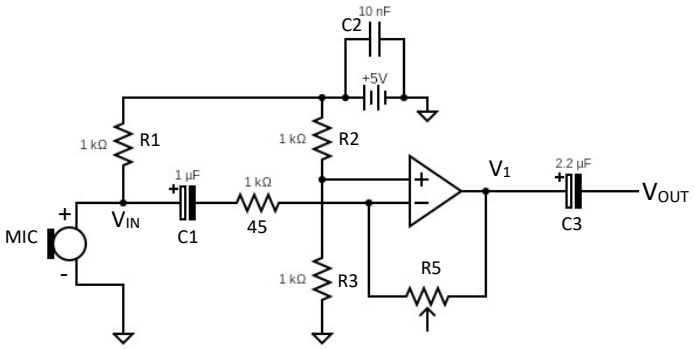
On changing DC offset



On reducing gain (from previous situation)

As we can see the original audio was amplified which can we feed to the next process of audio amplifying.

A better preamp can be built as follows



PARTS LIST

PART	VALUE	DESCRIPTION
C1	1uF	Microphone coupling capacitor
C2	10nF	Power supply decoupling
C3	2.2uF	Output coupling
R1	1k	Microphone load resistor
R2, R3	1k	Voltage divider : $1/V_{cc}$
R4	1k	Gain = - R5 / R4
R5	Potentiometer	
MIC		Electret Microphone

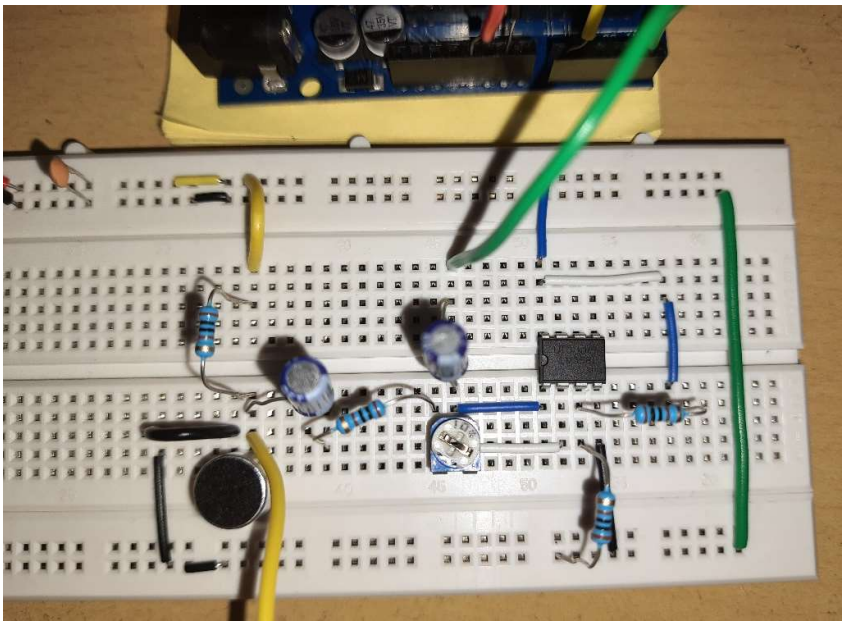
(V_{cc} = 5V here)

$$V_1 = -V_{IN} * R5 / R4 + VCC / 2$$

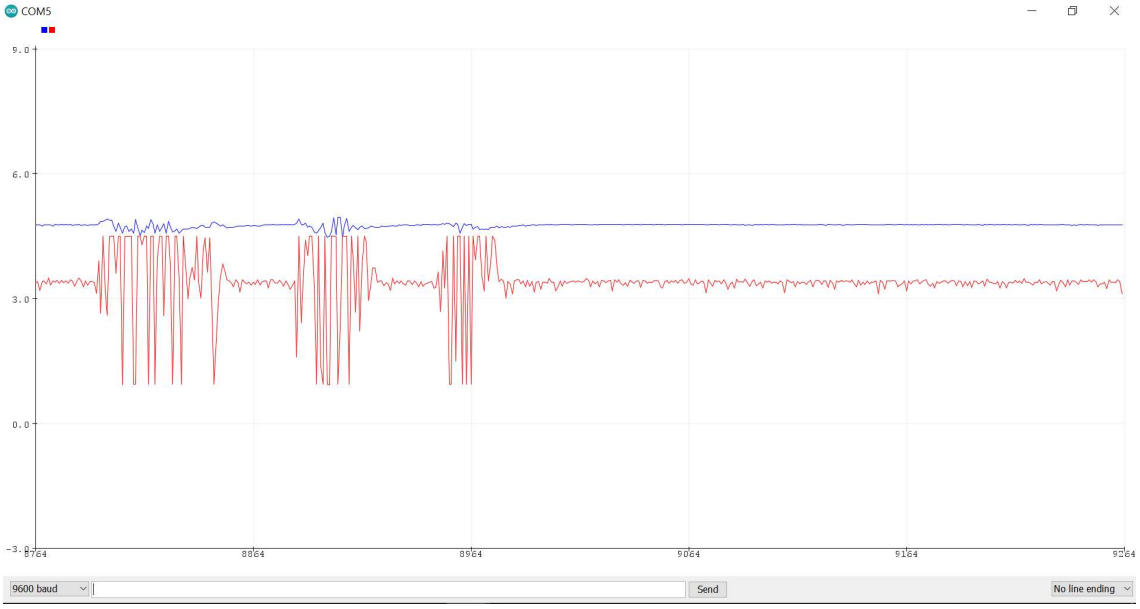
$$V_{OUT} = = -V_{IN} * R5 / R4$$

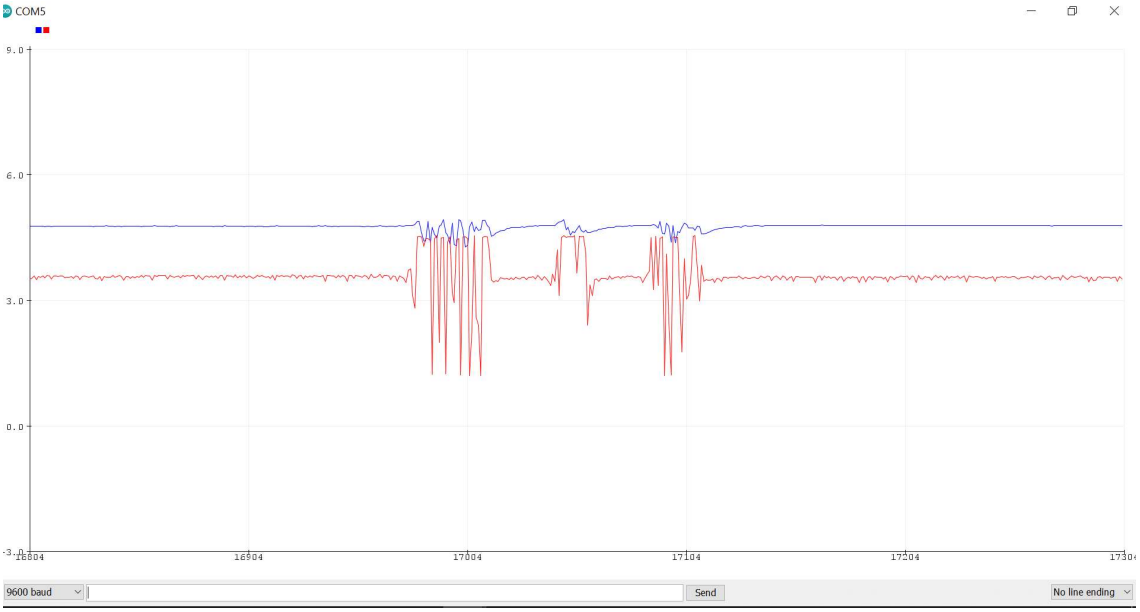
(as the C3 capacitor is blocking the DC component)

Circuit on breadboard is as follows

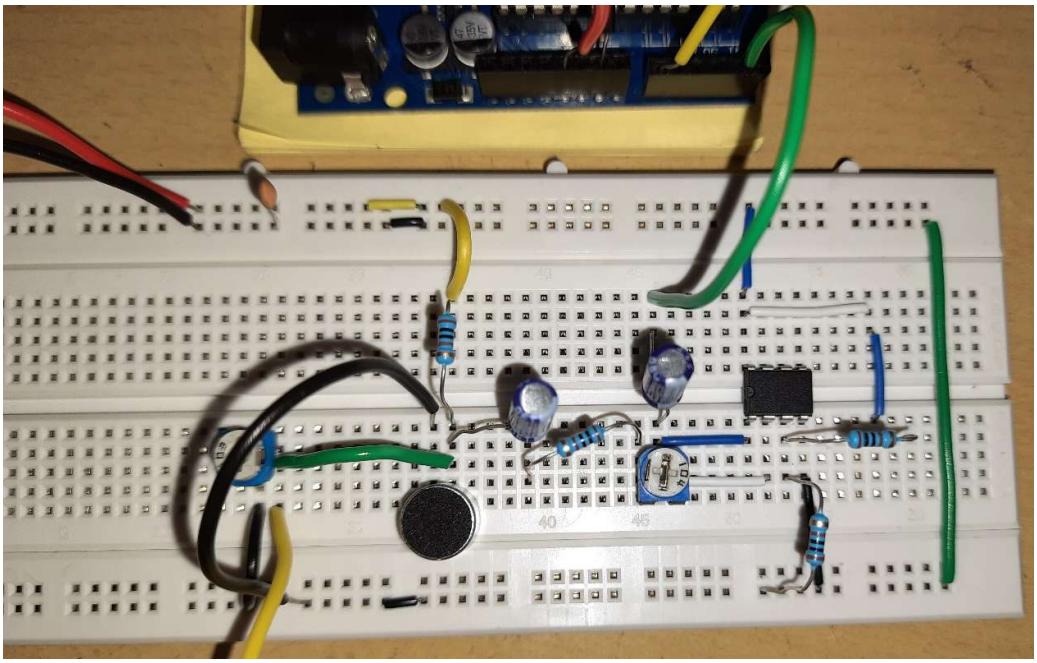


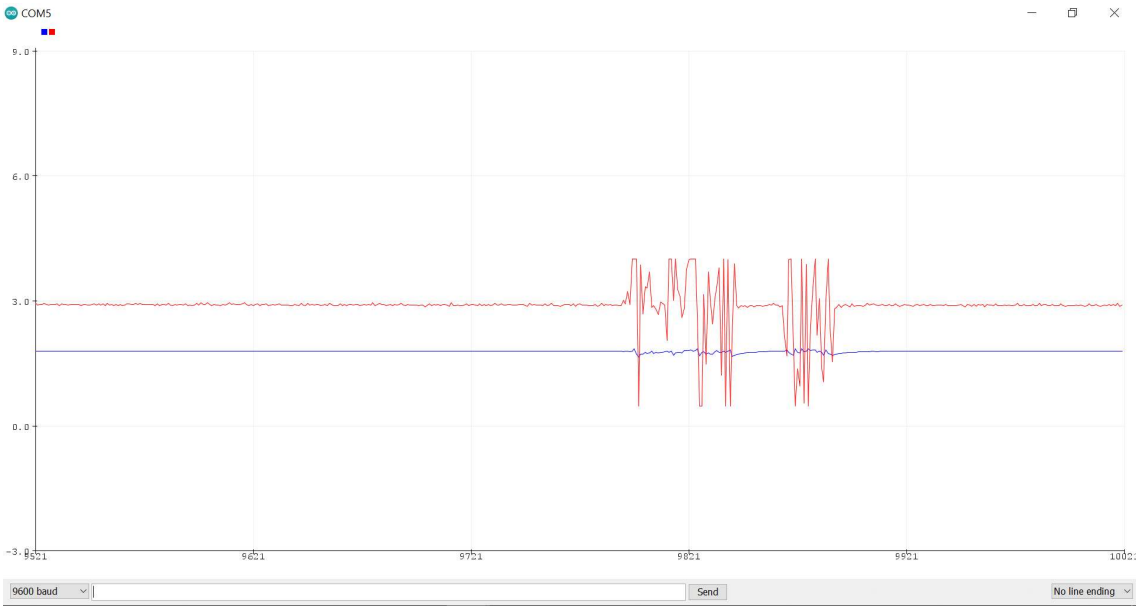
The Arduino output of the above circuit is as follows.





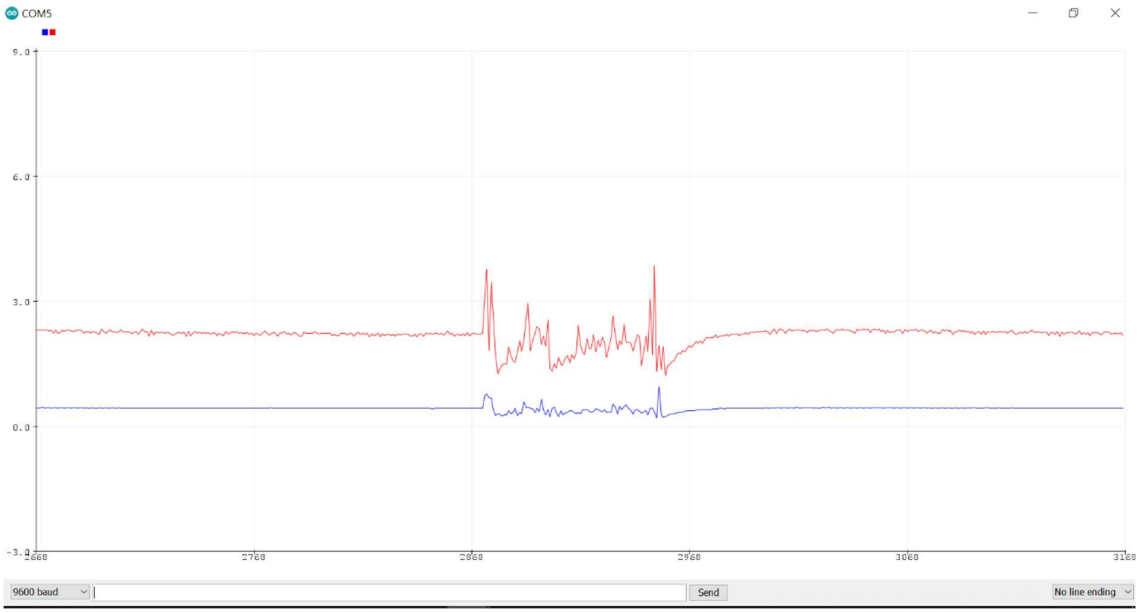
Below is the output when we introduce an dc offset.



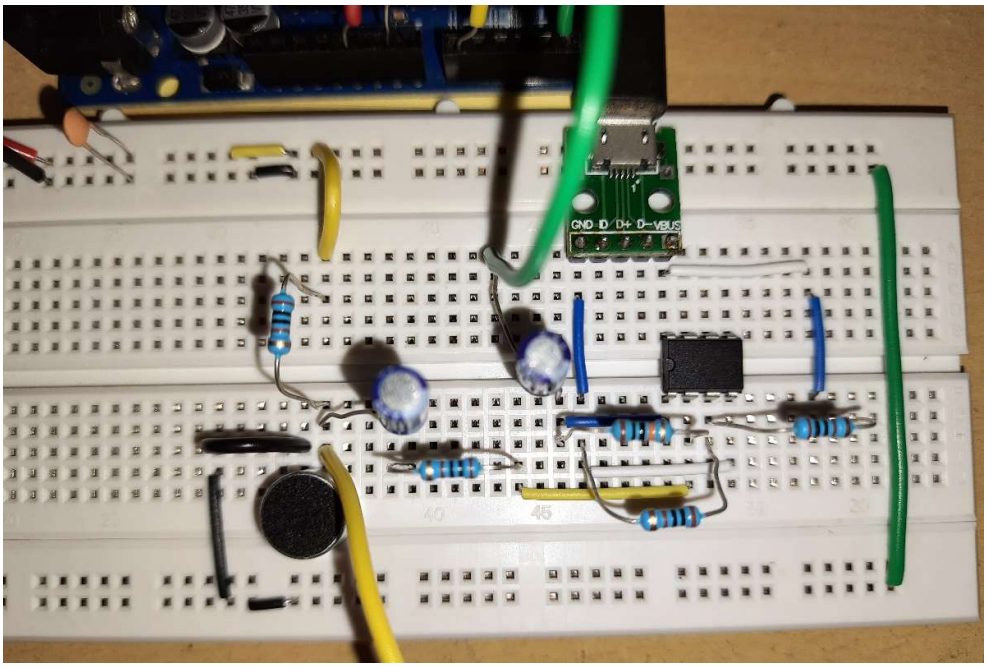


As we can see the input audio signal is amplified more than the first circuit.

We can increase the audio sensitivity further by using two voltage sources rather than one and we get the output as below.



For first circuit



(no variable gain)

For second circuit (shown on breadboard)

Code used in Arduino is as below

```
float Vin = 5;

void setup()
{
  pinMode(13,OUTPUT);
  Serial.begin(9600);
}

void loop()
{
  int data1 = analogRead(A0);
  float vol1 = Vin*data1/1023.0;
  Serial.println(vol1);
  Serial.print(",");
  int data2 = analogRead(A5);
  float vol2 = Vin*data2/1023.0;
  Serial.println(vol2);
}
```